**North Dakota Renewable Energy Program**
**Status Report**

Recipient: Evolve Analytics, LLC
Contract Number: R-045-055
Report for time period of: 02/01/2021 to 11/01/2021

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**Description of Project**
*Please provide a brief description of the project:*

Building on the success of an earlier Renewable Energy Program-funded project that revolutionized the commercial use of autonomous drones, this project seeks to expand on this promise of enabling minimally trained, onsite technicians to use drones for critical infrastructure inspection with push-button simplicity. More specifically, this project will focus on developing a full suite of artificial intelligence (AI) powered software applications including digital simulation (Microsoft AirSim), in partnership with private and public-sector entities, that promote the effective, efficient, and safe inspection of critical energy infrastructure related to its operation, regulation, and environmental impact.

The application of simulation will greatly enhance the ability to perform wind turbine inspections more easily, more effectively and more safely for the following: 1) blade condition assessment; 2) turbine component assessment; 3) severe blade damage detection; 4) blade icing detection; 5) avian mortality assessment; 6) substation inspection; and 7) power line inspection.

**Project Tasks**
*Please describe the progress on all project tasks achieved during the reporting period:*

- Develop Data Collection and Analysis Application for 7 identified applications

- Progress achieved: The application for Blade Condition Assessment that was developed, tested and deployed by Airtonomy staff in Phase 1 of this project has now been commercially adopted by 2 (two) entities and is in operation by on-site technicians on wind sites across the Midwest and Southern regions; Task completed in April 2021 (March 2021 target for project milestone).
- Progress achieved: The Turbine Component Assessment application was tested on customer sites following known events including blade icing, lightning strikes, and turbine faulting. (November 2021 target completion as project milestone.)
- Progress achieved: The Severe Blade Damage Detection application was tested with ML models developed for testing on-site; Demonstrated ability to respond to specific events (blizzard/ice storm in Texas) and with follow-up to lightning strikes at a customer site. (November 2021 target completion as project milestone.)
- Progress achieved: The Blade Icing Detection application has been developed with corresponding ML model and tested on-site on a customer wind farm with another co-development private-sector partner; Continued development of simulation to provide safe icing detection; (March 2022 target completion as project milestone.)
- Progress achieved: The Avian Mortality Assessment application that was developed in Phase 1 has demonstrated successful at avian (bird and bat) mortality detection with high fidelity of results including low false-positives and high species/sex identification of avian subjects; Comparative study of time/labor for manual vs autonomous inspection of potential avian mortality around wind turbines; continued development with UND Biology and F4 Conversation; (March 2022 target completion as project milestone.)
- Progress achieved: Under NDA with a regional power cooperative to co-develop Substation application. Initial scoping meetings conducted in Q1 & Q2 2021 and further project development to occur in Q4 2021 – Q1 2022. (April 2022 target completion as project milestone.)
- Progress achieved: The Powerline (or Distribution) application has been approved for co-development by Xcel Energy; scoping meetings and initial ML models have been completed; on-site testing projected for Q2 2022. (April 2022 target completion as project milestone.)

- UND Biology-specific tasks of avian mortality or Post Construction Mortality Monitoring (PCMM)
  - Progress achieved: Completed field work for a Validation Study – A real life simulation and comparative analysis of 180 plots between Spring and Fall, manual, ground-search inspection of post-construction wind sites for avian mortality and autonomous systems inspection and detection with ML model analysis; Imagery submitted for ML analysis with 2/3 complete with annotation and 1/3 (Fall-collected data) to be completed.
  - Progress achieved: Continued monitoring of regulatory environment and development of more efficient, effective regulation compliance that provides more cost-effective solutions for renewable energy operation and continued scaling.
  - Progress achieved: Developing a case for regulatory agency acceptance of autonomous inspection vs manual, ground search including a PCMM report to be provided to US Fish & Wildlife.
  - Progress achieved: First publication on the model development has been submitted to the Journal of Applied Ecology for review; This is the first of two planned publications (next is centered on Validation Study) and these two articles are the primary path to regulatory acceptance.

    - Progress achieved: Preliminary work is being completed on extending the ML-based PCMM work to other applications including airport related and oil spills.

- Co-develop with Microsoft AirSim on commercial product implementating of Synthetic Data through Hardware-in-the-loop as simulation tool for enhanced development, testing, and safety.
    - Progress achieved: development of simulated environments using Microsoft AirSim
    - Progress achieved: testing of VR simulation environment included on-hand demonstrations with the CEO of Xcel Energy and Senator John Hoeven at the Autonomous Nation event in September, 2021.
    - Progress achieved: Exclusive partnership (one of three entities to have the opportunity) to engage with Microsoft AirSim in the co-development of the vNext product to be available commercially in 2022/2023.
    - Progress achieved: on-site visits and project development by Microsoft AirSim representatives including Grand Sky, NPUAS Test Site and Grand Farm.

- Commercialize the Wind Turbine Inspection Application
    - Progress achieved: Xcel Energy entered into a contract to provide over 2100 wind turbine inspections using Airtonomy Solution over 13 sites across the nation
    - Progress achieved: Ottertail Power Co. contracted with Airtonomy for the inspection of 39 turbines using the Airtonomy Solution on North Dakota wind sites in 2021 & 2022.

- Safety case justification functional elements document
    - Progress achieved: Continue to work with Northern Plains UAS Test Site on the recommended a three-step sequence to obtain FAA operational waivers.
        1. Multi-Drone, Within Line of Sight (Complete)
        2. Multi-Drone, BVLOS
        3. Multi-Drone, BVLOS, Remote
    - Progress achieved: The FAA granted the corresponding multi-drone, within visual line of sight operational waiver at Xcel Energy sites.
    - Progress achieved: Xcel Energy, the Northern Plains UAS Test Site, and the UND RIAS all supported multiple efforts for Airtonomy to gain BVLOS approval from the FAA. Despite these efforts, approval has yet to be provided or rejected.
    - Progress Achieved: Beginning from the Phase 1 success of the FAA granting of the corresponding multi-drone, within visual line of sight operational waiver at Xcel Energy sites, the ongoing work includes using synthetic data (AirSim simulation) as a means to gain FAA approval for BVLOS approval.

- Refine current applications with new and future technology
    - Progress achieved: Large telecommunications partner-leveraged funding for 5G connectivity testing occurred in Feb-Mar 2021 with successful outcomes.
    - Progress achieved: Using initial test results, a continued development of 5G enabled hardware on Airtonomy Solution to future-readiness.

**Deliverables**

*Please describe the progress on project deliverables, as stated in your contract, achieved during the reporting period:*

- Develop, deploy, test, and commercialize 7 applications built using the Airtonomy platform, that combined will constitute a modern, robust, on-demand tool that technicians can operate with the push of a button.
    - Progress Update: *See specific application progress above*
- Validate the Federal Aviation Administration (FAA) safety case and associated simulation through physical testing at the selected ND Renewable Energy site.
    - Progress Update: Airtonomy has entered into an exclusive relationship with Microsoft AirSim and two other private sector partners to co-develop and refine commercially accessible simulation product; Continued development of simulation of wind turbine applications to deploy hardware-in-the-loop for validation of synthetic data use in development and testing environments.
- Successfully demonstrate to the FAA, safe deployment of Airtonomy capabilities to enhance on-demand, push button drone operations on Renewable energy sites.
    - Progress Update: No progress update at this time.
- Obtain a permanent FAA waiver for Airtonomy in relationship to wind energy sites.
    - Progress Update: A permanent waiver has not yet been obtained
- Seize a first of its kind opportunity by commercializating the Airtonomy solution, operated by on-site technicians (via a permanent FAA operational waiver), with the intention to grow market share within the Renewable energy and Utility Sector in real-time as the Federal Aviation Administration (FAA) loosens regulations such as Beyond Visual Line of Sight (BVLOS), which are led by the Northern Plains UAS Test Site, thereby allowing drones to operate in civilian airspace.
    - Progress Update: Two (2) customers have adopted the Airtonomy Solution for operation by on-site technicians in 2021 contracts.
    - Progress Update: Ongoing commercialization through new customer acquisition continues through dedicated sales strategy.
    - Progress Update: Permanent FAA operational waiver has not yet been obtained.

**Expenditures**

*Please provide a breakdown of expenditures. Include all sources of match. <u>Provide supporting documentation as a separate attachment.</u>*

| EXPENDITURES FOR THIS REPORTING PERIOD ONLY | | | | |
|---|---|---|---|---|
| **Project Expense** | **NDIC** | **Applicant (Cash)** | **Applicant (In-Kind)** | **Applicant Total** |
| *Personnel* | | | | |
| Project Director | | | $25,000 | |
| Operations | | | $23,000 | |
| Software Developers | | | $111,000 | |
| Computer Scientists | | | $120,000 | |
| UND Biology | | $7290 | | |
| UND RIAS | | | | |
| *Total Personnel* | | $7290 | $279,000 | $286,290 |
| *Equipment & Materials* | | | | |
| UND Biology | | | | |
| UND RIAS | | | | |
| Drone & Accessories | | $118,194 | | $118,194 |
| *Travel* | | | | |
| *Northern Plains UAS Test Site* | | | | |

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|---|---|---|---|---|
| *Software Development* | $342,401 | $104,196.25 | | $104,196.25 |
| *Other Direct Costs* | | | | |
| Airtonomy Platform | | | $83,333 | $83,333 |
| **GRAND TOTAL** | $342,401 | $229,680.65 | $362,333 | $592,013.95 |